Module 4 - Strain Gauges

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

Topic 2 - The Wheatstone Bridge

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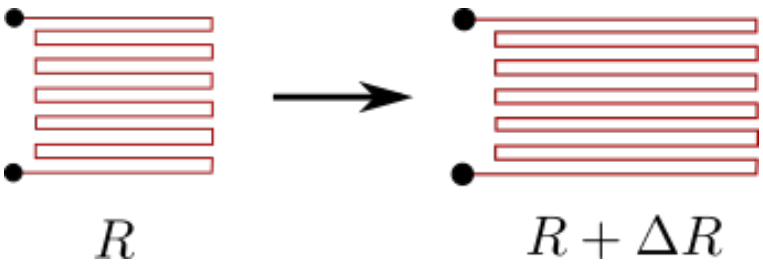
- Resistive Gauges
- The Bridge Circuit
- Balancing the Bridge
- Gauge Sensitivity

Resistive Gauges

The resistive strain gauge, aka *metallic gauge*, is bonded to the surface so that is deforms with the specimen. The change in length of the bonded gauge causes a change in resistance which is used as a measure of strain.

$$R = \rho_e L / A_c = fn(L, ...)$$



This is an exaggerated picture so the change is very small...

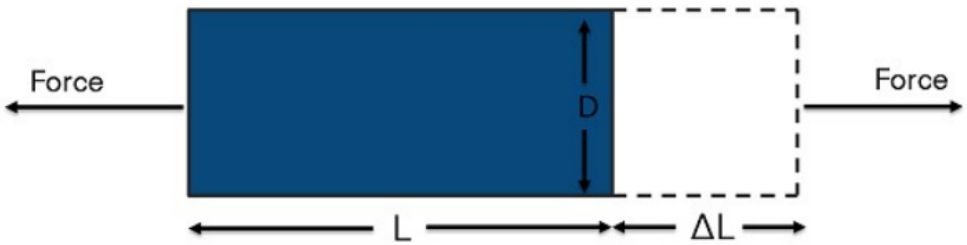
Images: T.Hill

Resistive Gauges

The Gauge Factor is typically used instead of the physical parameters.

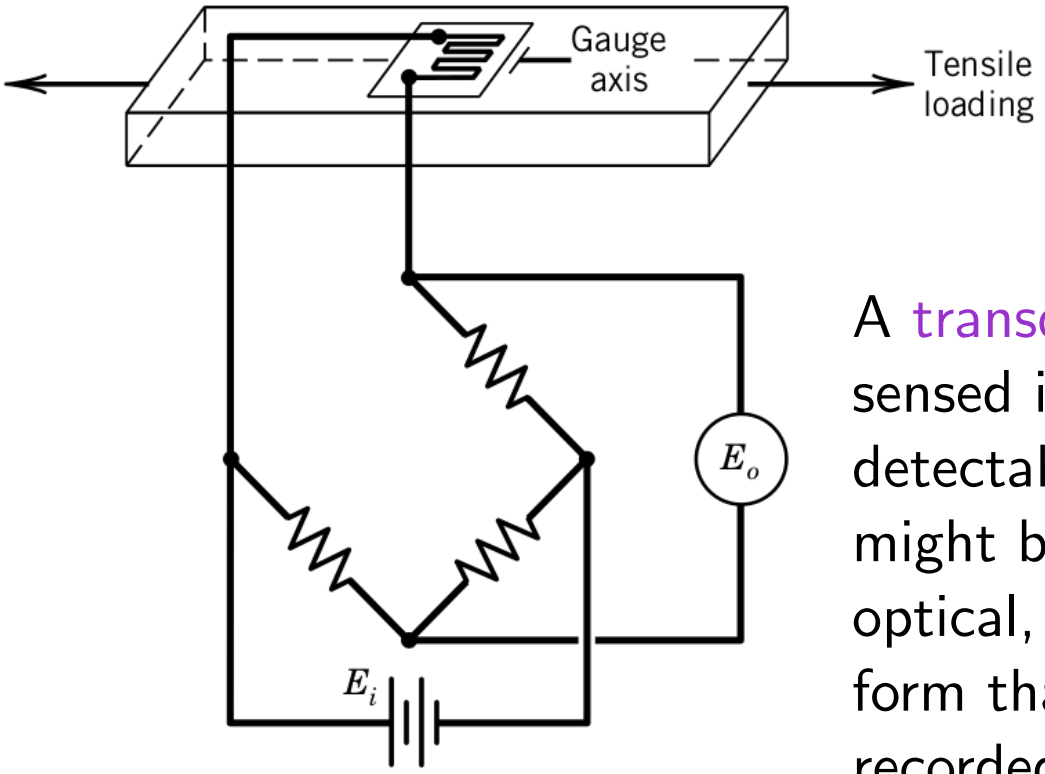
$$GF \equiv \frac{\delta R/R}{\delta L/L} = \frac{\delta R/R}{\epsilon_a}$$

This number relates the relative change in resistance to the measured strain.



Images: NI

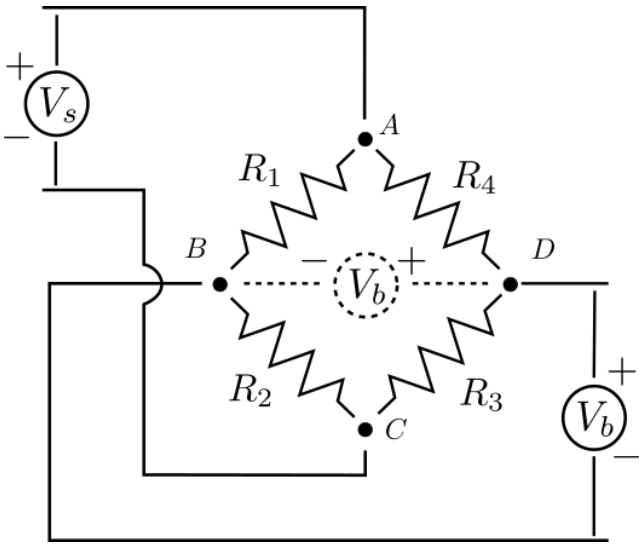
The Bridge Circuit



A transducer converts the sensed information into a detectable signal. The signal might be mechanical, electrical, optical, or may take any other form that can be meaningfully recorded.

Text. Images: Theory and Design for Mechanical Measurements

The Bridge Circuit



Images: T.Hill

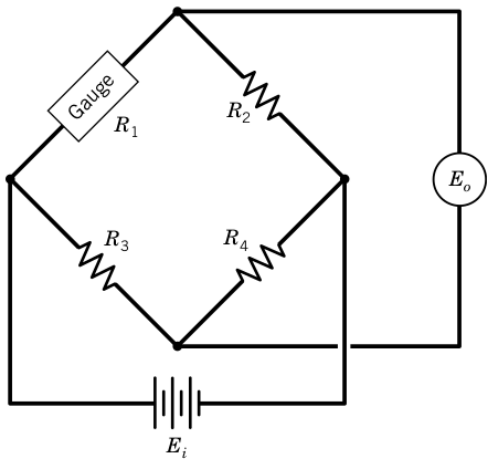
How does the bridge circuit work as a transducer?

Use KVL and the voltage divider rule find the relationship between the two voltages.

$$V_b = \left(\frac{R_3}{R_3+R_4} - \frac{R_2}{R_1+R_2} \right) \times V_s$$

Balancing the Bridge

If all four resistors are equal the bridge voltage will equal zero and the bridge is said it be balanced. One or more resistors in the circuit is replaced by a strain gauge and bridge voltage is used as a measure of change in resistance and therefore strain.



This gives a linear calibration curve with a convenient zero offset.

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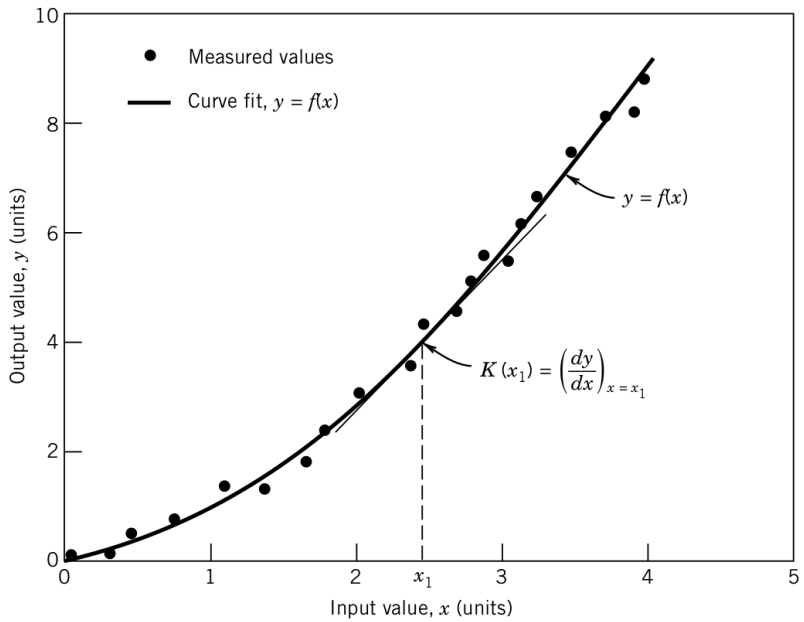
Gauge Sensitivity



Assume $R = 120\Omega$ for all resistors and the bridge is balanced in a condition of zero strain. What is the static sensitivity of the gauge and bridge circuit described?

K=

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Gauge Sensitivity

Gauge Sensitivity